Presentation To

RMRA Peer Panel

Day #1

Preferred Option and Risk Assessment

August 25, 2009

High Speed Rail Feasibility Study

TEMS, Inc. / Quandel Consultants, LLC

Development of the Preferred Option and Implementation Plan

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Results of Initial Screening

- **Route screening eliminations:**
  - North of Fort Collins, South of Pueblo due to inadequate demand.
  - West of Eagle due to high development cost with insufficient cost benefits.
- **Technology screening eliminations:**
  - **Eliminate 79-mph diesel on Existing Rail.**
    - Operating subsidy, negative cost benefit, low market penetration.
  - **Eliminate 110-mph diesel on Existing Rail.**
    - Could possibly work in I-25, but cannot go up I-70 mountain corridor.
    - An incremental rail solution has been suggested west of Eagle, but its evaluation was not funded within current RMRA project scope.
  - **Eliminate Maglev options.**
    - Maglev options have very high capital cost and produce marginal or negative cost benefit ratios.

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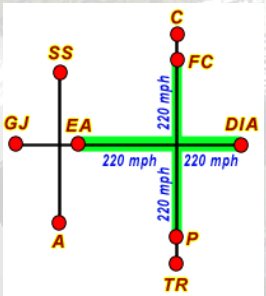
Retained Options



- **Focus on Core System:**
  - I-70 DIA to Eagle Airport
  - I-25 Fort Collins to Pueblo
- **Retain Double-Track Electric Rail Option**
  - High powered electric trains are needed for I-70 mountain corridor; given the capabilities of the trains, greenfield alignments give the best performance because of better geometry and stations.
  - Existing rail ROW constrains performance of electric trains leading to recommendation for greenfields.
  - The analysis has assumed that FRA Compliant trains would be used to retain the capability for right-of-way sharing if needed.
  - Short segments of existing rail right-of-way may be needed for downtown access in urban areas (Denver and Colorado Springs) and west of Minturn (or Pando) to Eagle Airport

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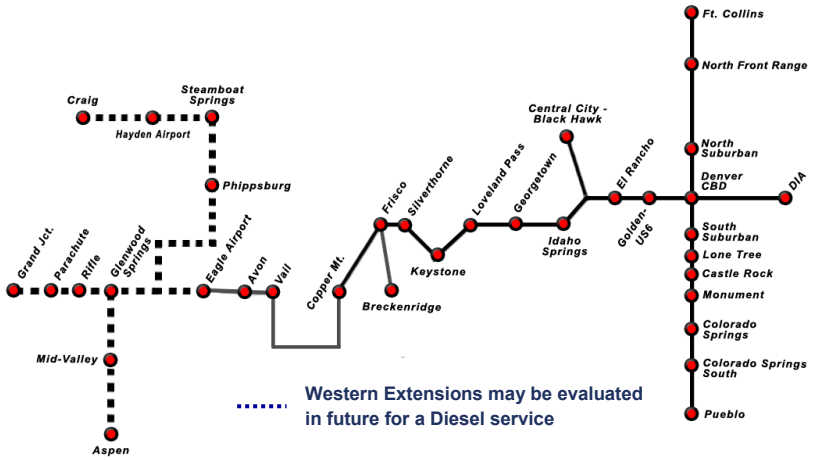
RMRA Preferred Option: Electric Rail

Uses greenfields except for short segments of shared rail ROW in urban areas and west of Pando



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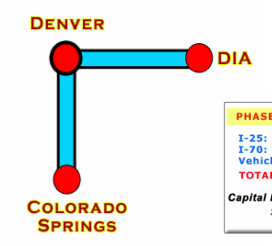
RMRA Implementation Plan Phases 1 & 2

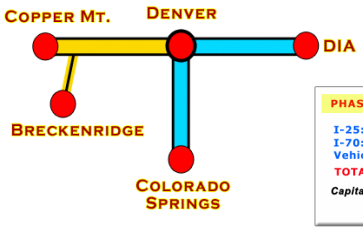
PHASE 1



PHASE 1: Capital Costs		
I-25:	2.66	Billion
I-70:	.19	Billion
Vehicle:	.48	Billion
TOTAL:	3.32	Billion

Capital Needed for Phase 1: *$3.32 Billion*

PHASE 2



PHASE 2: Capital Costs		
I-25:	2.66	Billion
I-70:	9.02	Billion
Vehicle:	1.20	Billion
TOTAL:	12.88	Billion

Capital Needed for Phase 2: *$9.55 Billion*

Key to Operations
Phase 1
Phase 2
Phase 3
Phase 4

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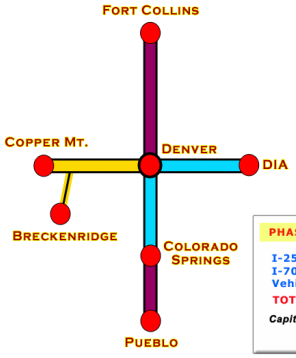
RMRA Recommended Routes Phases 3 & 4

PHASE 3

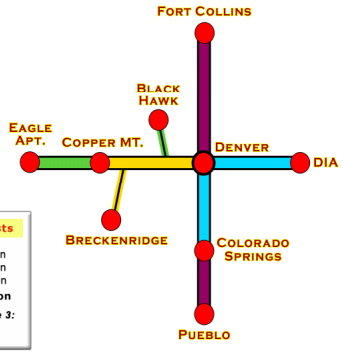


PHASE 3: Capital Costs

I-25:	5.96	Billion
I-70:	9.02	Billion
Vehicle:	2.00	Billion
TOTAL:	16.98	Billion

Capital Needed for Phase 3:
$4.10 Billion

PHASE 4



PHASE 4: Capital Costs

I-25:	5.96	Billion
I-70:	12.97	Billion
Vehicle:	2.20	Billion
TOTAL:	21.13	Billion

Capital Needed for Phase 4:
$4.15 Billion

Key to Operations	
Phase 1	
Phase 2	
Phase 3	
Phase 4	

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Preliminary Implementation Plan for the RMRA Preferred Alternative

RMRA Implementation	Billions ($2008)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PHASE 1	$2.84																
Colorado Springs - Denver - DIA		*PD/Environmental*					*B&N*		*Design/Build*			*T&C*	*Operations*				
PHASE 2	$8.83																
Denver - Silverthorne/Dillon/Frisco		*PD/Environmental*					*B&N*		*Design/Build*						*T&C*	*Operations*	
PHASE 3	$3.30																
Denver - Fort Collins / Pueblo		*PD/Environmental*								*B&N*		*Design/Build*			*T&C*	*Operations*	
PHASE 4	$3.95																
Frisco - Eagle Airport / Black Hawk		*PD/Environmental*								*B&N*		*Design/Build*			*T&C*	*Operations*	
VEHICLE PROCUREMENT	$2.20																
		Performance Spec.					*B&N*		*Design/Build*								

Total Investment	Billions ($2008)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PD/PEIS/EIS	$ 2.46	$ 0.06	$ 0.06	$ 0.06	$ 0.09	$ 0.44	$ 0.47	$ 0.47	$ 0.25	$ 0.27	$ 0.27						
Design/Build	$ 16.46								$ 1.92	$ 1.92	$ 1.92	$ 2.67	$ 2.67	$ 2.67	$ 2.67		
Total Infrastructure	$ 18.92	$ 0.06	$ 0.06	$ 0.06	$ 0.09	$ 0.44	$ 0.47	$ 0.47	$ 2.17	$ 2.19	$ 2.19	$ 2.67	$ 2.67	$ 2.67	$ 2.67		
Total Rolling Stock	$ 2.20								$ 0.26	$ 0.26	$ 0.26	$ 0.35	$ 0.35	$ 0.35	$ 0.35		
Total Investment	$ 21.12	$ 0.06	$ 0.06	$ 0.06	$ 0.09	$ 0.44	$ 0.47	$ 0.47	$ 2.44	$ 2.46	$ 2.46	$ 3.03	$ 3.03	$ 3.03	$ 3.03		

Key to Implementation Stages

PD/PEIS/EIS
Bidding & Negotiation (B&N)
Design/Build
Testing & Commissioning (T&C)

Key to Operations

Phase 1
Phase 2
Phase 3
Phase 4

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Financial and Economic Performance of the Preferred Alternative

System Revenues	$13.44B
Operating Cost	$7.08B
Operating Surplus	$6.36B
OPERATING RATIO (Revenue ÷ Operating Costs)	**1.90**

System Revenues	$13.44B
Consumer Surplus	$11.81B
External Mode	$8.04B
TOTAL BENEFITS	**$33.31B**
Capital Cost	$15.03B
Operating Cost	$7.08B
Infrastructure Renewal	$0.23B
TOTAL COST	**$22.35B**
COST BENEFIT RATIO (Total Benefits ÷ Total Cost)	**1.49**

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Freight Railroad Risk Analysis

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Freight Railroad Risk Analysis

- **Performed a Risk Analysis on use of Freight Rail Right of Way**
  - Bypass alternative via E-470
  - Elevated alternative over existing rail
- **The analysis was conducted as a Sensitivity to the double-track Electric Rail Preferred Option based on a fully built-out system**
- **Risk Analysis Parameters**
  - Capital Costs Range: *Low to High*
  - Bypass Speed Range: *Slow to Fast*
  - Compliant vs. Non-Compliant Equipment: *Capital and Operating Cost*

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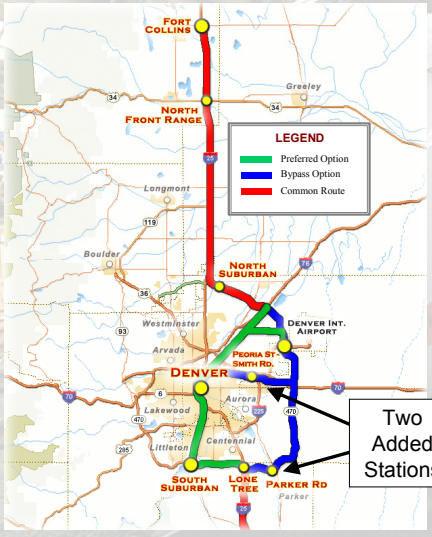
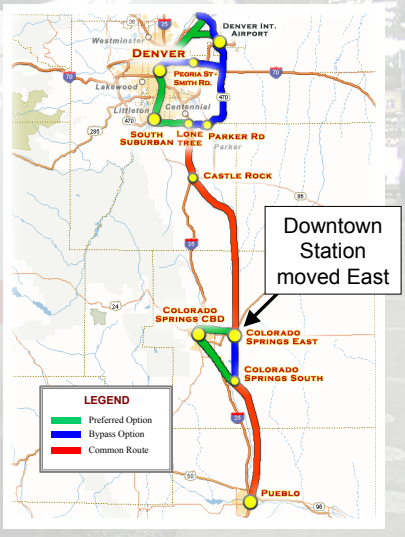
Risk Analysis Routes

I-25 North



I-25 South



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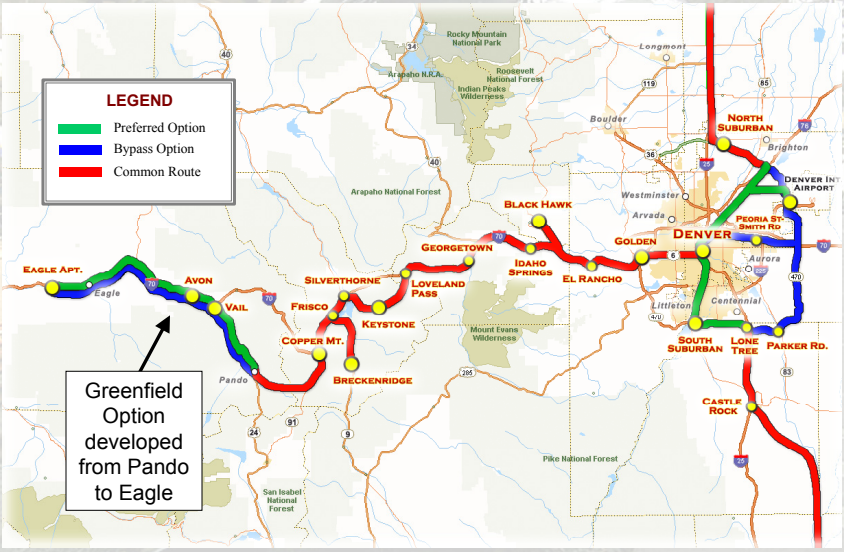
Risk Analysis Routes

I-70 West



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Risk Analysis Segments Summary

- **East Corridor from Denver to I-70/E-470 Interchange to DIA**
  - Continues to I-25 North, replacing the use of BNSF Brush Line
- **E-470 from Lone Tree to I-70/E-470 Interchange**
  - Replaces use of Joint Line from the South
- **Greenfield from Pando to Eagle Airport**
  - Eliminates use of UP Tennessee Pass Rail Line
- **Greenfield around Colorado Springs**
  - Bypasses the Joint Line through downtown Colorado Springs
- **Elevated Structures on Joint Line and Brush Line**
  - Stays on existing rail ROW, but provides vertical separation in areas where there is insufficient lateral clearance

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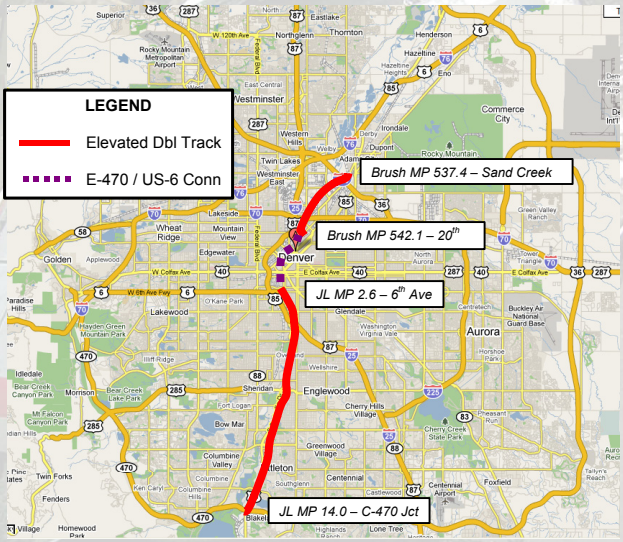
Risk Analysis Routes

Elevated Structures over Rail Right of Way



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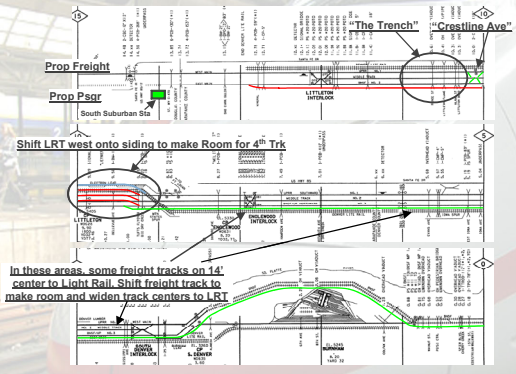
BNSF Meeting on August 20, 2009


"The Trench"
"Crestline Ave"
Prop Freight
Prop Psgr
South Suburban Sta
Shift LRT west onto siding to make Room for 4th Trk
In these areas, some freight tracks on 14' center to Light Rail. Shift freight track to make room and widen track centers to LRT

KEY

W/ R2C2

W/O R2C2

- BNSF Reviewed the Joint Line sharing plan presented to the Committee on Feb 27, 2009 and agreed to the feasibility of adding at-grade tracks in the Joint and Brush Line corridors.
- They felt the plan was a reasonable starting point, and saw value in the additional separation this plan would provide between freight and LRT operations.
- BNSF recommended next step: Preliminary Engineering and Detailed Capacity Analysis to be conducted by BNSF.

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Risk Analysis Routes

***OPTION 1*: Elevated Option** over Existing Rail through Denver (same alignment as the *Preferred Option*)

***OPTION 2*: Bypass Option** uses E-470 around Denver and I-70 corridor to east

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Time and Mileage Comparisons

Risk Analysis Options: to/from I-25 North Stations

Segment	Preferred and OPT 1 Elevated			OPT 2 Bypass (90mph) *			OPT 2 Bypass (60mph) *		
	Travel Time (min)	Distance (miles)	Avg Speed (Mph)	Travel Time (min)	Distance (miles)	Avg Speed (Mph)	Travel Time (min)	Distance (miles)	Avg Speed (Mph)
North Suburban - Denver	14	24	103	30	46	92	44	46	63
DIA-Denver	13	23	106	17	26	92	24	26	65
North Suburban - DIA	27	47	104	13	20	92	20	20	60

Risk Analysis Options: to/from I-25 South Stations

Segment	Preferred and OPT 1 Elevated			OPT 2 Bypass (90mph) *			OPT 2 Bypass (60mph) *		
	Travel Time (min)	Distance (miles)	Avg Speed (Mph)	Travel Time (min)	Distance (miles)	Avg Speed (Mph)	Travel Time (min)	Distance (miles)	Avg Speed (Mph)
Lone Tree - Denver	13	23	106	26	40	92	33	40	73
Lone Tree - DIA	26	46	106	19	28	88	26	28	65
Lone Tree - North Suburban	27	47	104	32	48	90	46	48	63
Pueblo-Lone Tree	59	98	100	51	92	108	51	92	108

KEY
Better
Worse

** Because we do not have geometry for the E-470 Bypass, two different options were developed as sensitivities on Average Commercial Speed (with stops) of 60-mph and 90-mph*

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Ridership and Revenue Performance

Risk Analysis Options

Option	Ridership	Ridership % of Pref Alt	Consumer Surplus ($mill)	Rev ($mill)	Passenger miles (Mill)
Preferred and OPT 1 Elevated	34,186,288	100%	$811.57	$807.56	2,494
OPT 2 Bypass (60-mph)	32,368,990	95%	$758.68	$840.78	2,453
OPT 2 Bypass (90-mph)	35,504,284	104%	$866.46	$918.85	2,684

Bypass options:

- Regardless of speed, the Bypass worsens I-70 and downtown Denver connectivity from I-25 both North and South
- However, it puts DIA directly on the I-25 North corridor, and adds a strong Aurora station at the I-70 / I-225 Junction
- Net Impact:
  - A 60-mph bypass *worsens* ridership due to added time.
  - A 90-mph bypass *improves* ridership due to added Peoria Street/Smith Road station and better DIA connectivity.

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Specific Corridor Ridership Impacts

Option	I-70 West	I-25 North	I-25 South
OPT 2 Bypass (60-mph)	90%	110%	98%
OPT 2 Bypass (90-mph)	96%	124%	106%

- **I-25 North corridor: *Positive***
  - DIA Airport connectivity and the Peoria Street / Smith Road station
  - Ridership improves even for the 60-mph bypass
- **I-25 South corridor: *Mixed***
  - 60-mph Bypass degrades ridership in spite of new stations.
  - 90-mph Bypass improves ridership
- **I-70 corridor: *Negative***
  - Bypass options degrade connecting ridership
- **Overall: *Depends on the Speed of the Bypass***

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Colorado Springs Greenfield Impact

- **The Colorado Springs downtown station was moved to a suburban location along US-24 in Cimarron hills on US-24**
  - The proposed South Colorado Springs stop in fountain was retained, on the greenfield alignment it is very close to the Colorado Springs airport
  - Access to some zones that formerly associated with the downtown station are now more convenient to the South Colorado Springs (airport) station
  - As a result, traffic at South Colorado Springs (the airport) increased in the bypass option while the Colorado Springs East stop (relocated downtown station) decreased
- **With two station stops, the greenfield alignment around Colorado Springs saves 6 miles and 8 minutes compared to the downtown route, resulting in faster service to all points north**
- **Since trains to Denver are faster than before and because of the zone reallocation, *shifting the downtown station to the suburban location did not harm total ridership at Colorado Springs***

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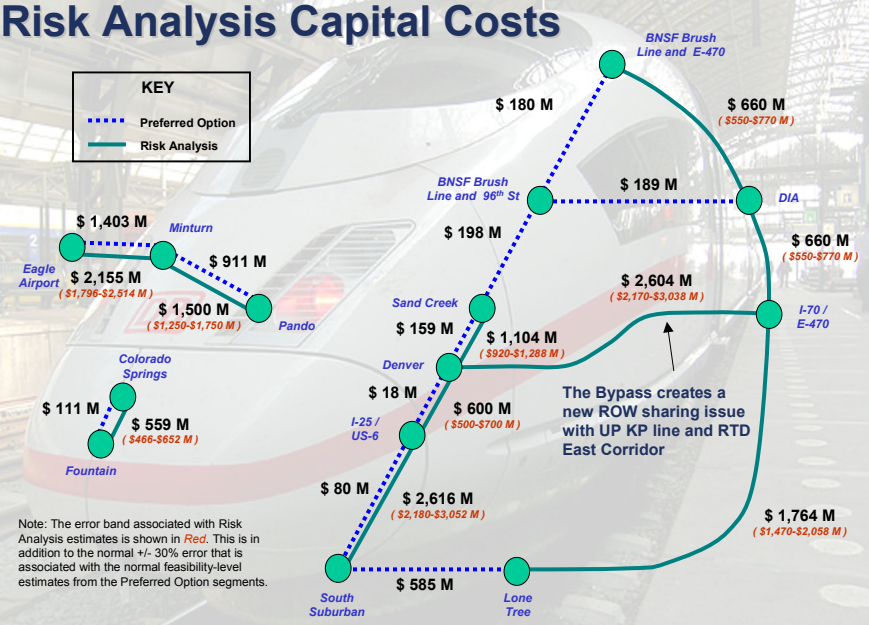
Risk Analysis Capital Costs



Note: The error band associated with Risk Analysis estimates is shown in *Red*. This is in addition to the normal +/- 30% error that is associated with the normal feasibility-level estimates from the Preferred Option segments.

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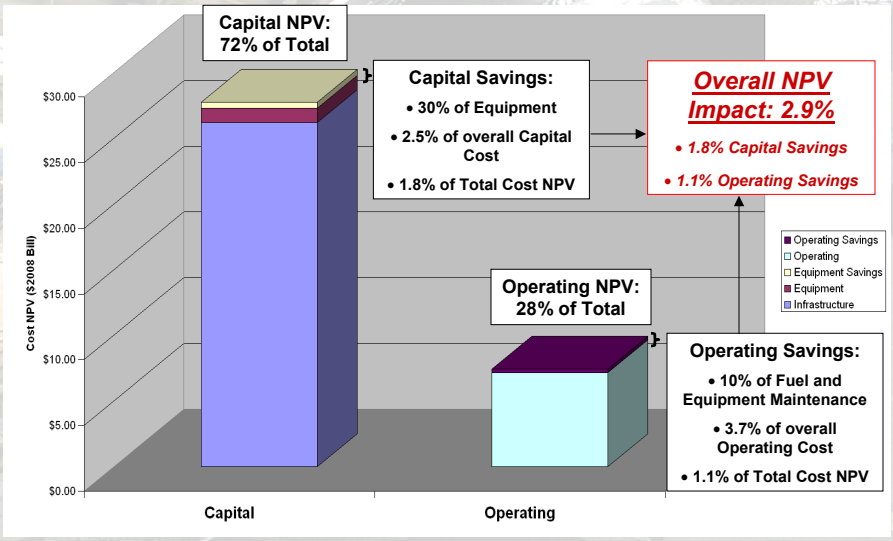
Impact of Non Compliant Equipment

on Cost Benefit Ratio



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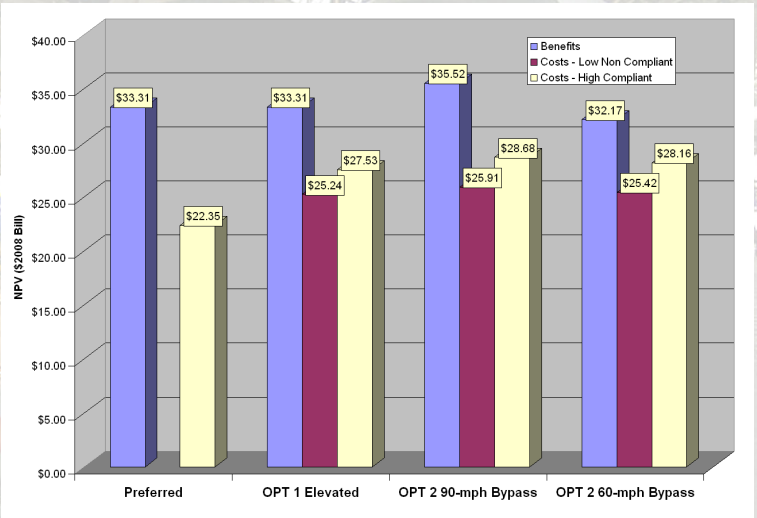
Risk Analysis: Cost Benefit Ranges



- Best Case – Low Capital Costs, with Non Compliant Equipment
- Worst Case – High Capital Costs, with Compliant Equipment

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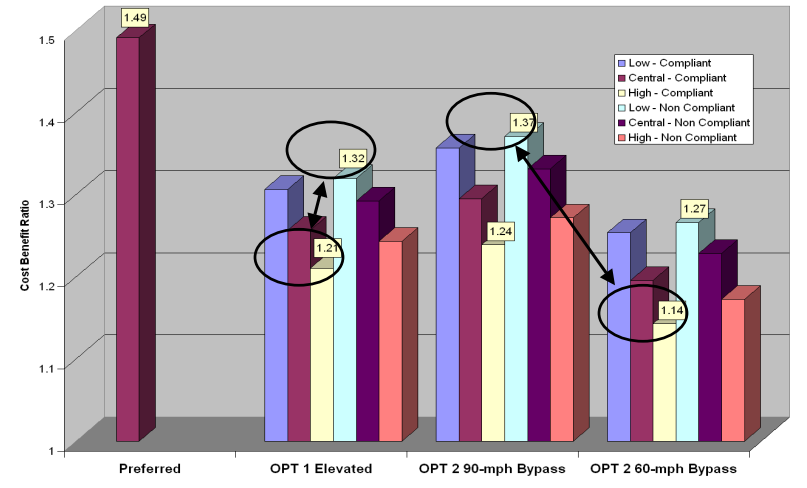
Risk Analysis Results



- Since we do not have geometry for the E-470 bypass, we need to combine the ranges for the two speeds. The cost benefit ratio could range from 1.14 up to 1.40 depending on the final configuration.

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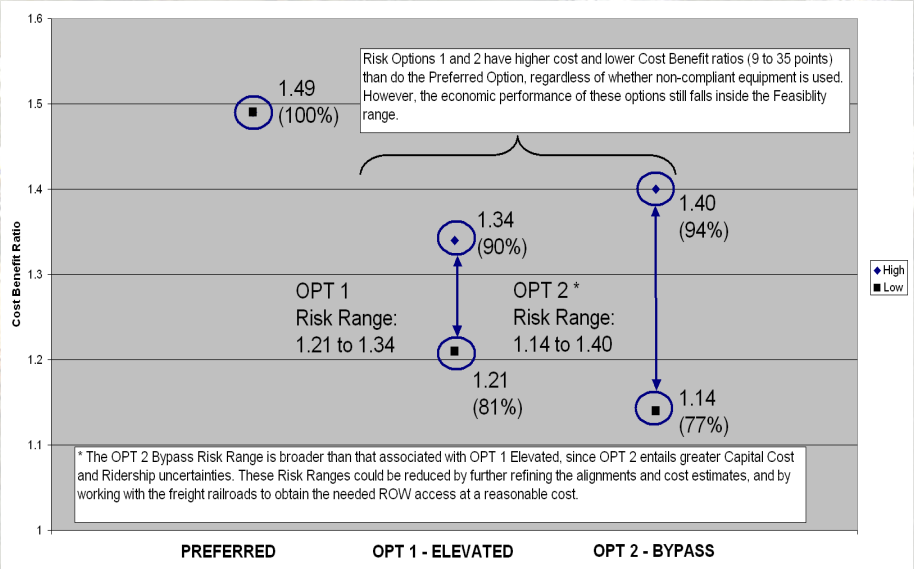
Risk Analysis Summary


1.6
1.5
1.4
1.3
1.2
1.1
1
Cost Benefit Ratio
Risk Options 1 and 2 have higher cost and lower Cost Benefit ratios (9 to 35 points) than do the Preferred Option, regardless of whether non-compliant equipment is used. However, the economic performance of these options still falls inside the Feasiblity range.
1.49
(100%)
1.34
(90%)
1.40
(94%)
OPT 1
Risk Range:
1.21 to 1.34
OPT 2 *
Risk Range:
1.14 to 1.40
1.21
(81%)
1.14
(77%)
High
Low
* The OPT 2 Bypass Risk Range is broader than that associated with OPT 1 Elevated, since OPT 2 entails greater Capital Cost and Ridership uncertainties. These Risk Ranges could be reduced by further refining the alignments and cost estimates, and by working with the freight railroads to obtain the needed ROW access at a reasonable cost.
PREFERRED
OPT 1 - ELEVATED
OPT 2 - BYPASS

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Risk Analysis Conclusions

- **The downside risk is 6-23% on the Cost Benefit ratio. All the Risk Options are still viable, but they produce lower Cost Benefit ratios than the original Preferred Option.**
- **Station issues to be further examined in future studies:**
  - Routing the DIA Airport line via Peoria Street / Smith Road station would be a definite plus, but its feasibility depends on resolving potential ROW conflicts with UPRR and the RTD East Corridor.
  - Through routing service via DIA is beneficial to the I-25 North corridor, but if the airport terminal is not served directly, this gain must be traded off against any detrimental impact on DIA airport ridership and revenue.
  - An east suburban Colorado Springs station in conjunction with the greenfield option maintains ridership.
- **If E-470 rail can be built with good geometry, and if access can be gained from E-470 / I-70 to downtown Denver at a reasonable cost, then the E-470 Bypass option could work.**

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Thank You.

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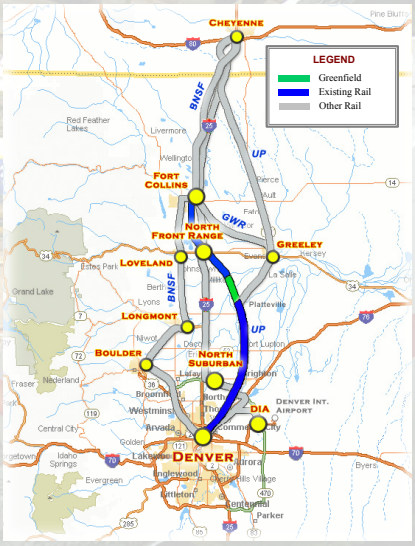
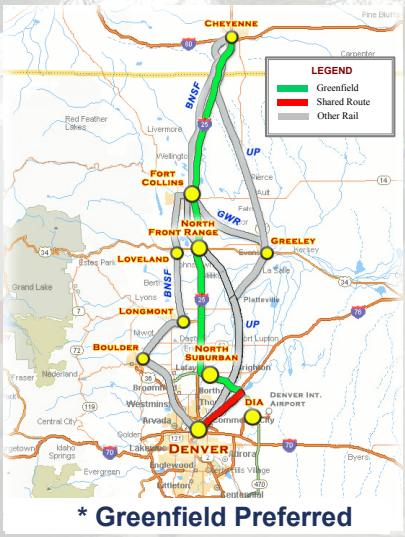
I-25 North – "Milliken" vs I-25 Greenfield





* Greenfield Preferred

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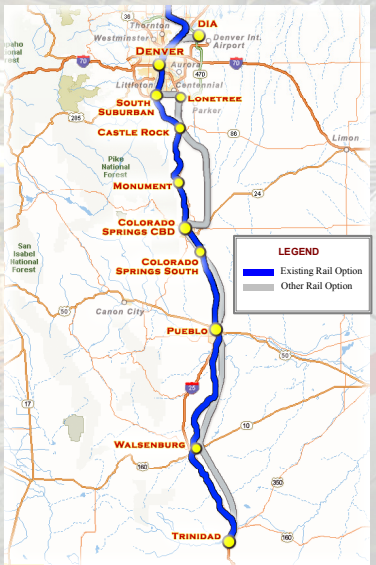
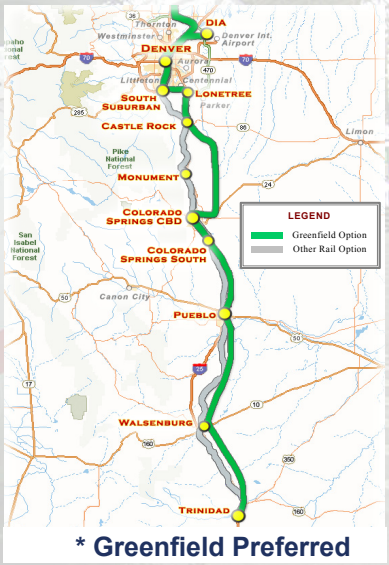
I-25 South – "Joint Line" vs Greenfield





* Greenfield Preferred

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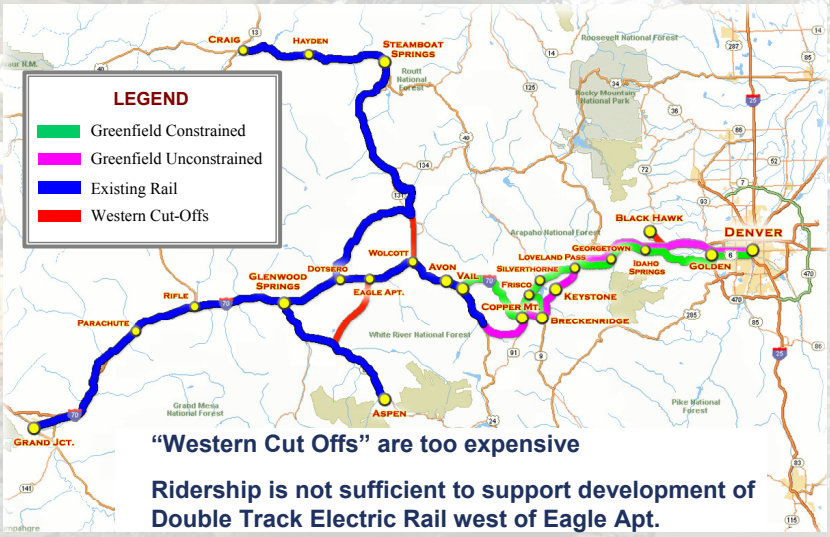
I-70 West – I-70 ROW vs Unconstrained



"Western Cut Offs" are too expensive

Ridership is not sufficient to support development of Double Track Electric Rail west of Eagle Apt.

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